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ASPECTS OF MODERN PSYCHOLOGY[1]

By Dr. CHARLES S. MYERS

ENGLAND

Two hundred years ago psychology had no independent existence. But it was fast developing in importance and towards differentiation from the universe of philosophy to which it then belonged. In the year 1740, Berkeley and Hume were still living; Kant was in his teens; Locke, Malebranche and Leibnitz had not long since died, and the elder (James) Mill, Herbart and Lotze were yet unborn. Hitherto the concern of philosophers with what was to become psychology had had chief reference to their speculations upon the nature of knowledge and understanding and upon the relations between mind and matter. But now their interests and observations were becoming increasingly psychological in other directions; and they were fore-shadowing views and attitudes which were to achieve prominence and importance throughout the history of psychology after its emancipation.

It was the mathematical and biological sciences that helped finally in the birth of psychology as a separate field of study and as an experimental science; they likewise played a part in the emergence of political economy and education, respectively, also out of philosophy. After a sterile mathematical treatment by Herbart of the higher mental processes in the early

[1] Address delivered at the Bicentennial Celebration of the University of Pennsylvania, September, 1940.

years of the nineteenth century, came Fechner's more attractive mathematical study of the relation between sensation and stimulus. At the same time Flourens, followed by Helmholtz, Hering and others, was applying the methods of physiological experiment to the study of the functions of the central nervous system and of the sense-organs. Wundt, who had taught physiology at Heidelberg for seventeen years under Helmholtz, came to take an increasing interest in philosophy and psychology on the transfer of Helmholtz in 1871 to the professorship of physics in Berlin. In 1875 he was offered a professorship in philosophy in Leipzig. At that university, Fechner, like Helmholtz and Wundt, a graduate in medicine, had been working, at first occupying the chair of physics until a long illness enforced his retirement. Thereupon he took up the study of philosophy and psychology, with especial devotion to psycho-physics and esthetics. With the practical aid thus received from mathematics and physiology, together with the motherly support of philosophy, Wundt founded at Leipzig the first "institute" of psychology—the first laboratory of experimental psychology. Although formally established in 1879, his institute was not recognized by the university until 1886.

In France the encouragement of experimental psychology came not so much from physiologists and their interests in sensation and in sensori-motor response, as from medical clinicians engaged in the treatment of disorders of personality, in the study of hypnotism and in the problem of the mentally defective. It was thus that the early work of the first psychological laboratory in Paris came to center about suggestion, fatigue and intelligence. These problems, although emanating from medical practice, received experimental investigation in a purely normal, purely scientific, atmosphere.

To Wundt at Leipzig, mainly on account of his keenness for experiment, and partly because at that time Germany was educationally their "spiritual home," flocked numbers of American students who were later to become the leading psychologists in this country: from England he received but two pupils, Titchener and Spearman, who afterwards achieved distinction in the subject. Of all these Titchener, who throughout the long tenure of his professorship at Cornell retained his British nationality, alone remained faithful to the main articles of faith emanating from Wundt's institute. For Titchener as for Wundt, psychology's task was to analyze mind, in the fashion of the chemist, into its simplest components and to re-synthesize these elements under experimental conditions; for him the elements consisted of sensations, images and feelings.

The living mind soon began also to be systematically studied in much the same way as the living body; and this application of the biological standpoint to psychology quickly led to a differentiation of the subject into various branches according to the aspect from which it was being thus scientifically investigated. Initially, as we have seen, there had arisen *psycho-physics* and *physiological psychology*—each directed to discover the relations between mental, neural and physical processes. Encouraged by the new doctrine of evolution, *animal psychology* rapidly came to the fore; and simultaneously came the study of the development of the mind in the human being—during infancy, throughout childhood and adolescence—and its regression in old age, *i.e., genetic psychology*. Next came the study of mental differences between the races of mankind (*comparative psychology,* as it is sometimes called), the study of the mental life of communities and their institutions (*social psychology*) and the study of mental differences between human individuals (termed by one of its founders *differential psychology*).

In Great Britain the application of scientific psychological methods to the last-named study, of individual mental differences, is immortally associated with the name of Francis Galton; and in the United States of America with that of James McKeen Cattell, whom, now in his eightieth year, it is especially fitting to mention on the present occasion because of his connection with the University of Pennsylvania. Cattell was one of Wundt's earliest students. There is a story told of him that one day he approached Wundt, saying "Herr Professor, you need an assistant, and I will be your assistant." And Wundt's first assistant in the Leipzig institute Cattell became. In 1886, on his return to America, Cattell lectured at the University of Pennsylvania and here in that year laid the foundations of a psychological laboratory, although it was not until 1889 that the laboratory was adequately equipped and formally opened. The claim has therefore been made that this university possesses the oldest psychological laboratory in America that has had an uninterrupted existence from its foundation down to the present day. Here, too, the first American chair in psychology was founded: it was occupied by Cattell until, in 1891, he went to Columbia University, where he established another psychological laboratory.

Professor Cattell's interests lay not in introspection, one of the main pillars of the Wundtian school, but in the psycho-physical and statistical problems underlying mental measurement—interests which have been continued by Professor S. W. Fernberger, who occupies a professorial chair here to-day. They lay especially in the study of individual mental differences as revealed and measurable in human behavior; and these originated experimentally in the "personal

equation" which had for some time disturbed the observations of astronomers and had received close study in the early years of the Leipzig laboratory under the form of "reaction times." It became Cattell's aim to estimate human capacities: indeed he was the first to use, exactly fifty years ago, the now familiar expression "mental tests," urging with prophetic insight their future importance. His work, thus begun at the University of Pennsylvania, paved the way for the later "schools" of behaviorism and factorial analysis.

Yet another branch of psychology, which so far I have left unmentioned, with the early development of one aspect of which the University of Pennsylvania has again been intimately concerned, is *abnormal psychology*. This university was the first to found a "psychological clinic" for the study and treatment of mentally abnormal children. It was formally established here by Professor Lightner Witmer in 1897. Witmer, like Cattell whom he followed in the directorship of the psychological laboratory and in the chair of psychology at this university, is happily also with us. Like him, Witmer received his doctorate from Wundt at Leipzig and, like him, his interests have been mainly centered in individual mental differences. But these differences have been of a psychopathic order, relating mainly to those revealed in the school-room or in the juvenile court. The success of his pioneer work is attested by the fact that "psychological clinics," or "child guidance clinics" as they are now often called, are to be found to-day in every community that can claim to be interested in its own social welfare.

Witmer's efforts afford an early example of a series of further, later, *applications* of psychology, not only to education, delinquency and medicine but also to other branches of sociology—to art, religion and especially to occupational life. One of his pupils, Professor M. S. Viteles, of the University of Pennsylvania, is one of the most distinguished "industrial" psychologists throughout the world.

It should not be a matter for surprise that the scientific, biological study of mind has opened out so many different aspects or branches of psychology. In biology, the science of the *living body*, a corresponding number of sub-divisions can be easily recognized. Biology comprises—botany and zoology, with their numerous sub-divisions into mycology, bacteriology, protozoology, helminthology, etc., up to anthropology; the different aspects of study indicated by physiology, pathology, anatomy and histology, together with embryology, genetics, bio-chemistry, neurology, cardiology and so forth; and their various "applications" to medicine, surgery, hygiene, agriculture, etc. It is therefore no disparagement to psychology, the science of the *living mind*, that, with its differentiation as a separate discipline of knowledge and research, we are able similarly to record the development of physiological, animal, comparative, genetic and differential psychology, psycho-pathology (*i.e.*, medical or abnormal psychology), educational psychology, industrial (or, better styled, occupational) and social psychology, and the special relations of psychology to religion, art, crime, etc.

The one important branch of psychology which finds no real analogy on the biological side is "differential psychology." As a natural science, psychology studies individual *mental* differences from the functional standpoint—in order to arrive at a clearer idea of the nature of mind. *Average* memory, *average* threshold, *average* imagery, *average* personality, "mind in general," these pall in interest compared with the psychological study of the *individual* and of *individual* differences. To the biologist, on the other hand, individual *bodily* differences among the members of a species have so far offered little or no attraction from the standpoint of function. His only interest in them comes with an approach from the genetic side—the inheritance of characters and the acquisition of new characters through environmental changes. The biologist in the past, like the physicist, has been largely interested in classification. Classification was for Aristotle a main *raison d'être* of science; the individual peculiarities of cases had therefore to be ignored so far as possible; cases had to be placed as comfortably as possible in the nearest class or type into which they would fit.

It was in imitation of this early procedure of the natural sciences and in the desire to make psychology a branch of natural science, that neither Wundt nor Titchener, with their accent on introspection, took any real interest in individual mental differences. Moreover, despite their devotion to introspection, they did not wish to accentuate the necessarily personal, "private," feature of the *mental* objects of psychological study, compared with the "public" character of the *material* objects of physical and biological study. For the same reason (introspection here being impossible or unreliable) animal and child psychology did not interest them; nor could they find room for abnormal and applied psychology, as they were undertaking pioneer work for the recognition of a pure science.

As has been pointed out, psychology shows at least as many different aspects, judged by the number of its branches of study and the diversity of its applications, as does biology. Appealing as they must to an enormous variety of interests and talents both among psychologists and biologists, they can in every way justify their existence. But in the case of psychology, there is another series of aspects which finds little or no analogy in biology nor indeed in any other natural science. These aspects reflect individual differences in

attitude, of a more profound philosophical character, among the past and present leaders of the subject, which have resulted in the development of a number of *schools* of psychology—some now defunct or moribund, others still active and, until recently at least, in violent opposition to one another. To the outside world it may seem that, if psychology is to be regarded as a natural science, there can be no reason for the existence of these antagonistic schools, unless it be the unsettled state of the whole subject or of the particular branches of it with which they deal, or the fanatically narrow and intolerant mentality of those who are at their head. Wundt provided a striking example, *more Germanico,* of this dictator-like attitude of a school head; it was faithfully copied by Titchener in America, and was later adopted in Vienna by Freud. A young student of mine happened once to mention to Freud the name of Alfred Adler, one of his most distinguished pupils, who had been driven from his school because of disagreement on scientific matters: "ich kenne ihn nicht" was the reply that he received.

And yet, despite their radical differences of outlook, Freud, Jung and Adler have doubtless had equal success in their medical practice. In the matter of treatment, therefore, the extent to which "sexuality," the "collective unconscious" and "inferiority" play their roles, as variously advocated by the leaders of these three schools, would seem to be of secondary importance, compared with the enormous influences of suggestion and the revival, explanation and redintegration of repressed, distorted complexes. Each was neither by temperament nor by training a man of science. He attempted to build an incomplete system of psychology based fundamentally on the observation and treatment of psycho-neurotics. In the case of Freud, at least, this embodied a gloomy, cheerless view of life, a life of incessant conflict and repression, in which consciousness was of relatively little concern or potency and was always being caught off its guard by the irresistible, subterranean, hostile, unconscious, mental forces of the libido. Each leader poured forth floods of hypotheses and explanations, and these attracted (strangely like psychical research) literary people and physicists rather than those who had received a systematic training in psychology. Freud himself once said about certain views that he had proposed, "I am neither convinced myself nor am I seeking to arouse conviction in others. More accurately I do not know how far I believe in them." Starting with tentative hypotheses, he would too often raise them quickly to the status of important principles, and later be equally ready to abandon them. Loose terminology, needless anthropomorphisms and ridiculously wild generalizations have, from the scientific standpoint, been the ruin of these men of genius.

It remains for the future to sift out and to combine into an integrated system what is, and will undoubtedly be found to be, true in the teachings of these three schools—of psycho-analysis, analytical psychology and individual psychology. Assuredly their leaders' influence will never die; psychology will never be the same as it would have been, had they never lived. We know now from their labors that there is no hard and fast line to be drawn between the normal and the psycho-neurotic—just as we know now that the people of intelligence shade imperceptibly into the mentally deficient. Our scientific concepts of the unconscious and of mental inhibition or repression have become vastly changed and widened; our old ideas of the relative importance of reason and emotion in determining human conduct are now almost reversed; and such current popular expressions as "wishful thinking," "extraversion" and "inferiority" attest the wide-spread influence of these schools of "depth" psychology. Who can read Freud's "Traumdeutung" without admiration for his original, ingenious and invaluable analysis of what he calls "the dream work"?

Yet another rival leader in psycho-pathology, Janet, has developed concepts which will be everlastingly useful in general psychology, those, for example, of dissociation and of psychic stress and tension. But some schools of psychology are not to be ascribed to the particular genius—or to the failings—of their founder. They are inevitable, because inevitably psychology can be approached from very different standpoints with different aspects of truth peculiar to each. These different approaches are beneficial to the progress of the entire subject, because they enable quite different paths to be cut with the aid of quite different weapons. The weapon may be sometimes borrowed from physiology, psychiatry, education, zoology or mathematics, experts in which are attracted to psychology often without having received adequate training in it. Their contribution is frequently helpful in a circumscribed field: their failure comes when, founding a school, they attempt to extend the fruits of their narrow specialization to gathering a wider harvest—when they come to believe that the weapon which they are using is the sole weapon by which progress is possible, whatever be the psychological path taken.

There have been psychologists like William James, whose outlook was too wide and catholic, whose weapons were too varied, to found a school; of the schools that have developed since his time, many could have turned to him, each claiming encouragement and support. G. E. Müller, the beauty of whose experimental methods in psychology has never been approached, was another who did not attempt to establish a school. Not less distinguished a psychologist, Stumpf, left behind him these words:

I have never endeavoured to found a school in the strict sense, and have found it almost pleasanter, certainly more interesting, to have my students reach different conclusions than to have them merely corroborate my theories.

The inadequacy of the early schools of Wundt and Titchener was soon recognized. They both did admirable work, and were often criticized unjustly for views which they could never literally have accepted. Broadly speaking, they regarded the mental world as the physicist regarded the material world—as a vast mechanism driven by discoverable laws (among which those of association loomed large), analyzable into elements, and describable in abstract terms void of purpose, value or meaning. They regarded psychology, to use their own language, as the study of experiences considered as dependent on a central nervous system and on an experiencing person. They were distantly interested in the relation of the central nervous system to these experiences, but they made no attempt to bring the psychology of the experiencing person under scientific examination. As a natural science, psychology had discarded the soul; and with the soul went the self or ego, the most obvious discovery of introspection!

In the time of Wundt, atoms too small ever to be visible were the ultimate particles recognized by physicists. The latter, in accordance with the second law of thermodynamics, regarded the world as a huge mechanism running down after having been once wound up—as if it were the creation of an *engineer*. To-day mathematical physics, dealing with electrons and quanta, has entered the field. It regards the world as unsubstantial—as if it were the creation of a *mathematician*. The individual electron has no real separate existence: it is in this respect a mathematical fiction, sometimes needing to be regarded as a particle, sometimes as the center of a wave disturbance. The experimental physicist is in danger of being ruled by the mathematician, his discoveries having to be incorporated within an unreal world of mathematical relations connecting unimaginable entities. The pass to which mathematics has thus reduced physical science is the ultimate issue of its own procedure. The more exact a physical experiment, the more artificial, unreal and abstract it becomes. At each stage of analysis, as lower and simpler levels are reached, something is lost: for the whole is more than the sum of its parts. As by synthesis we pass upwards from what we have ultimately reached by analysis, new properties, new characters, "emerge" which are not in the parts: so the properties of water emerge from the union of hydrogen and oxygen, and the characters of the living emerge from those of the lifeless world; and so too conscious activity would be described as emerging from reflex activity, could we succeed in analyzing the former into the latter. In such analysis ultimately a scheme of purely symbolical data is employed, conjoined by mathematics. Science, as thus engaged, has no concern with meanings or values, nor with history or purpose.

Psychology can do the same, it can pose as a natural science and reduce itself to mathematical symbols. But it can also pose as one of the humanities. It is perhaps this dual aspect of the subject that has attracted those who have achieved the greatest distinction in it. They have been men imbued with a love for experimental and analytical science combined with a love for living experience and for philosophy or the other humanities. And according to their major interest they have leaned rather to the mechanistic or to the humanistic standpoint. In Germany extreme regard for the latter standpoint has produced a school of *Verstehende Psychologie* under the successive leadership of Dilthey, Spranger and others, who have felt that for the true "understanding" of the individual human mind the principles not of natural science but, as they term it, of *Geisteswissenschaft* are needed, the latter starting with the totality of mental structure, the former with the study of physical elements. This school does not hope to reach more than broad types, ideal not real, of personality, culture, etc., by generalization and abstraction from the observation of individuals, the study of autobiographies and history, etc. Its real aim is the study of the *unique* individual and of the laws governing the individual, that will indicate, to use G. W. Allport's words, "how uniqueness comes about," corresponding to the objects of the study of history, religion, art, etc., to which psychology must ever furnish an important base.

The contrast between the ideals of this school and those of Titchener's "existential," "structural" or "introspective" school, as it has been variously named, could not well be greater. But however "scientific" its intentions and tenets, Titchener's school did not, as a school, outlive its founder. However valuable, introspection and observation came to be regarded as insufficiently trustworthy for the discovery of mental elements. It became increasingly clear that structurally all mental experiences can not be analyzed into, and expressed in terms of a mosaic of sensations, images and feelings, and that learning and remembering (at all events where meaningful matter was concerned) depended on other important mental processes than on merely mechanical associations. Moreover, in the first place, it was felt, especially by psychologists in America, impossible to neglect the study of the "functional" aspects of mind—the study of the vital services rendered by consciousness to the organism in the adaptation of the latter to its physical and social environment, the special needs of the organism served by per-

ception, emotion, etc. Thus Dewey, followed by Angell, started in America the *functional* school of psychology, Jastrow stressing its *genetic* aspect.

In the second place, the *dynamic aspect* of mind was also stressed, by Woodworth, as deserving of closer study. There is far more in a percept than a "bundle" of sensations, far more in thought than a train of images; and there is far more in perceiving or thinking than mere percepts or thoughts. A part of that "more" consists in the character of the operation or "act," and in the direction and determinants of the responsible forces of mental activity. Thus we are led to study the roles and the varieties of "drives" and motives, interests and attitudes, instincts and habits, alike in experience and in behavior, and the general study of conduct in relation to the unconscious, as well as to the conscious, mind. "Dynamic" psychologies arose which originally had for their object the discovery of a relatively small number of basic elementary units in the various forms of instincts, propensities, tensions, needs or motives—common, it was believed, to all individuals and adequate, it was hoped, to account for the unique conduct and the unique personality of each. But the insufficiency of this simple "scientific" standpoint is becoming increasingly recognized, as has been lately emphasized by G. W. Allport in his admirable volume, "Personality: a Psychological Interpretation." The complex systems of motives in later life are functionally unrecognizable in their crude infantile and childhood origins.

Thus came about a tendency, even also among experimentalists, to start from and to stress the unique, unitary self or personality, with its drives, needs, interests, traits, attitudes and purposes, and its universe of meanings and values. This tendency arose also from the realization that living processes, whether mental or bodily, can not be *completely* studied from the synthetic direction, owing to their possession of the character of "goal-seeking." It led to the schools of *hormic* (or *purposive*) and of *personalistic* psychology founded by Nunn and McDougall and by Stern respectively. For Stern the "person" was of a psychophysically "neutral" nature—neither psychical nor physical but transcending each: thus he hoped to bridge the gulf between abstract scientific knowledge and psychical reality!

Such a revolt from the contemporary standpoint of natural science was bound to have its consequences on those who approached psychology from that standpoint. What is it, they asked, that prevents psychology from being treated as a natural science? It is because the characters of mind, as observed by introspection, are the *private* concern of the introspecting "subject." They can only be communicated to others by oral or written report, *i.e.*, by movements; they can only be studied and measured by their actual expression, *i.e.*, by movements. Movements are like the other "objects" studied by natural science; they are the *public* concern of all who care to attend to them. Natural science has to exclude, as Piéron well expresses it, what "can not become the object of collective experience." Why then, it was asked, should we not make psychology a natural science by studying exclusively the movements, *i.e.*, the behavior, of the individual in response to the stimulus and with regard to its environment? And thus arose Watson's *behavioristic school*, an extremist attempt of the animal psychologist to dispense with all reference to consciousness in any form.

With the same aim Pavlov and Bechterew in Russia started their schools based on their independent discovery of the "conditioned reflex." (This was also simultaneously and independently discovered by Professor E. B. Twitmyer, a member of the present staff of the psychological department in the University of Pennsylvania.) They held firmly to the idea that all mental responses could be derived from the reflex. They were fully satisfied with the sufficiency of the old doctrine of associationism to account for mental integration, the learning of ideas and of skills and their reproduction. What could be simpler than to construct an analogy between the higher neurones, united one to the other by synapses, and ideas, united through association? But extreme behaviorism, through its unreflecting imitation of the procedure of natural science, is confronted with the same abstract, unreal situation as physics—a situation which is logically and mathematically correct, but which is not the teaching of common-sense every-day life. It is forced to maintain the two absurd standpoints that consciousness is of no biological, functional, significance whatever in human and animal life; and that the highest, noblest mental responses and personality itself are nothing more than the mechanical integration of the lowest and simplest reflexes.

Eddington has remarked of physics, "we rig up some delicate physical experiment with galvanometers, etc., specially designed to eliminate the fallibility of human perceptions; but in the end we must trust to our perceptions to tell us the result of the experiment." So too, in fact, it is impossible for the extreme "behaviorists" to dispense entirely with consciousness. Their successors, indeed, the milder "neo-behaviorists," could not fail to recognize the part which their own conscious selves play in their interpretation of their animals' behavior; as they admit, the introspections of a conscious subject are merely replaced by the interpretations of a conscious experimenter. Indeed by one of these "behaviorists" mental processes have been freely accepted as "inferred determinants of behavior

which ultimately are deducible from behavior," instead of being as the "mentalist" assumes, "essentially inner happenings primarily available to introspection only." A broadly "behavioristic" attitude has spread widely among experimental psychologists during recent years. But the tenets of the school are far from being accepted in such an extreme sense as its founders desired. "Conditioning" in the laboratory proves to be definitely different from "association" in every-day life. There is a growing recognition, too, that if the "behaviorist's" observations are to be confined exclusively to animals and infants, experimental conditions must often be artificial and unnatural; while the urges, drives and tensions studied must relate largely to sex and food, to the exclusion of the higher moral and artistic needs and creative activities of man.

Allied to this school is that of *operationism,* recently welcomed from the side of physical science, according to which a concept can only be defined in terms of some objective technique, *e.g.,* by the corresponding set of "operations" that have been designed to assess it. For many years psychologists engaged in mental testing have had to be content with defining "intelligence" "operationally"—as being what is measured by intelligence tests. Adherents of this school have attempted to give similar operational definitions to other mental terms, thus, in *quasi*-behavioristic fashion, hoping to establish a psychology which will give an objective rendering of all subjective terminology. It is possible, but, as I have urged, it is insufficient, to regard psychology as a science in which the "private," personal, nature of mental experience is transformed into arrays of symbols which have been derived from "publicly" observable events, *i.e.,* behavior.

(To be concluded)

IS THIS SUCCESS?

By the late Dr. ROYAL N. CHAPMAN[1]

TO-DAY I shall be alone. So far as I know there is no one on the boat who would recognize me. Tomorrow the passenger list will be published, and then there will be introductions and interviews. It has come to the point where I find seclusion only on an airplane where the roar of the motors precludes conversation, on a train or on a day like this on a boat. It is a far cry from a youthful ambition for the life of a naturalist emulating Thoreau and Burroughs to a strenuous program of consultations and the direction of research.

It required a great mental adjustment to pass from a self-supporting student interested in the development of socialism to the direction of a research institution on which a great, highly capitalistic industry depends. It has meant the transition from the problem of choosing each meal according to the money in the pocket to the problems in which millions are won and lost. More than all else it has involved ideals, the realization of which I once thought to be the object of my life.

A former college mate with whom I shared the struggle for advanced degrees in a well-known graduate school recently reminded me of one of our idealistic discussions, in the course of which I had expressed myself as to a salary which would satisfy all my financial ambitions. He called my attention to the fact that my present salary is ten times the maximum that was specified in those days of the graduate grind. He asked what it was all about. Had I forgotten that we had pledged ourselves to the exploration of nature, not for material wealth but for the discovery of her laws of the interrelationship of organisms? Did I no longer share that aversion for a materialistic world which spends half its time chasing the almighty dollar only to spend it on movies, motor cars and jazz? Was it not as true as ever that society must learn to use its leisure with books and nature rather than at horse racing and dancing, if a high order of civilization was to be maintained?

I have been searching for the answer to his questions in the snatches of time when I have been looking down from the clouds or across the sea. The question was presented anew day before yesterday when an interviewer began with one of those flattering introductions, saying that she was writing a series of articles for a well-known magazine on successful men, and that I was on her list. The interview was postponed, but it renewed my reflections.

After all, is this success—this crowding out of

[1] This essay by Dean Chapman was found among his papers after his death, December 2, 1939, at which time he was dean of the Graduate School of the University of Minnesota. It was written in December, 1938, when he was director of the Experiment Station of the Pineapple Producers Association of Honolulu, Hawaii, and while he was on the boat going from Honolulu to this country. It was on this trip that he received and accepted the offer to become dean of the Graduate School at Minnesota, which office he assumed in the summer of the following year, 1939. During his short term of office as dean of the Graduate School he took up again his early morning insect research on "little universes under controlled conditions" and happily returned, as far as the administrative duties of his office permitted, to a realization of the ideals of his youth's enthusiasm.

ideals by the high pressure of the modern world? Were the old ideals wrong? Did they belong to the past generation and was the gradual transition which crowded them out only an expression of nature's law of progress? Has this change indicated that I have been successful in keeping abreast with the modern world, or a weakness in giving up my ideals?

It all came about so gradually that I was not aware at any time of a decision that meant this change. All temptations which seemed to involve a sudden departure were turned down; and there was a series of them. But little by little it came about.

When I received my Ph.D. degree I accepted an instructorship with a salary of little less than an average clerk would receive, married a girl who believed in me and shared my ideals and who had been receiving a salary larger than mine. We worked together with enthusiasm, for she too had been an instructor in the same university. We studied the birds and insects of our neighborhood and began a detailed study of the animal population of a fresh-water lake.

Then war came. I was not accepted for active duty but discovered that my science could be applied to war-time industries. When the war was over there were demands that I continue my industrial activities. The university made the necessary adjustments, and week-end trips half way across the continent began. All vacation time was spent wrestling with industrial problems. Each one looked like an exception. It was worth thousands to the industry and would be solved in a few days or weeks. But there were no more vacations in the north woods where we used to travel by canoe and live in our little shelter tent, studying the things that were to be the object of our life work.

Through it all my university schedule was left inviolate. This other work was relegated to week-ends and vacations. But a change came in the university work also. Gradually I became involved in the direction of graduate students, and the undergraduate classes were shifted to other instructors. I became the head of a department. As time went on it was evident that these graduate students who came even from foreign countries were interested in the economic application of my work and not in my "ideals." They soon absorbed all my regular hours outside of class.

There were still two things left; a class of freshmen during three months each year who did most of their laboratory work in the field, and my own hours between four and eight in the morning. I enjoyed the enthusiasm and curiosity of the undergraduates and told them that there would be nothing in the course that would ever be worth any money to them, but that I hoped they would learn of other things in this world which are worth more than money. Life need never lose interest for them, I said, for there were "books in running brooks." Possibly they were the only ones who believed me, for the dean and the president continued to ask for instances wherein I had saved thousands of dollars for industries, which they could put in their annual reports or their speeches to the commercial clubs. I think their ideals were like mine, but they were feeling the same economic pressure as I, and they were closer to its source.

Hemmed in by modern methods of transportation and communication, I couldn't enjoy the seclusion of a monk's monastery, so I made the Einsteinian substitution of time for space and had my monastery in a modern laboratory between the hours of four and eight in the morning. This meant no parties or theaters the night before, but it was my own time, before I had been tired by the daily duties of my position.

To be sure these hours were not adapted to field work, but I created artificial environments and put populations of insects in them which behaved like little universes under controlled conditions. And I studied them without interruption while the economically minded world slept.

The trips away got longer and the problems more involved. I crossed the Atlantic and the Pacific, went from the Arctic Circle to the Sahara Desert. Now the undergraduates have dropped out of the picture. My work is essentially administrative and the direction of research which is of more economic importance than ever. My time is so expensive that I can not afford to do anything that any one else can do for me. Interviews must be short in order to get them all in during the course of the day. I must make all decisions myself, for I have no colleagues with whom to consult. I sit alone with my judgment, but I am never alone with myself.

My wife has the social obligations that belong to our position and our home establishment and servants to preside over. In our new environment we are surrounded by strange plants and animals, but we have had no time to get acquainted with them. The ideals that I once had and tried to give to the freshmen seem to be gone. It is harder than ever to get up at four o'clock. The transition seems to have been made.

I am not unhappy in it all. I have become attuned to it. I find it hard to relax when I have a few minutes to myself. I shall probably enter into the activities of life on the boat while others will read books, because it is hard for me to let down.

The interviewer asks if she may tell the world how I achieved success; my college mate asks what it is all about. A former professor of mine said that success was the attainment of one's ideals. I look across the sea from my deck chair and wonder. Has the old order changed and is this the new? Is this success?

SCIENTIFIC EVENTS

GIFTS TO SCIENCE AND EDUCATION

THE annual report for 1940 of Dr. Frederick P. Keppel, president of the Carnegie Corporation, gives a list of large sums given or bequeathed for scientific and educational purposes during the period covered by the report. These include a new foundation with a capital of $8,000,000 that has been established through the will of the late Charles E. Culpeper, of New York, for the support of charitable, religious and educational organizations. Significant additions to the resources of existing foundations have been made as follows: to the Kresge Foundation, $7,650,000 from S. S. Kresge, of Detroit; to the Kress Foundation, $1,000,000 from Samuel H. Kress, of New York; and to the Murry and Leonie Guggenheim Foundation, $5,000,000 by bequest of Murry Guggenheim to enable its dental division to erect, equip and operate a dental clinic for the children of Greater New York. Eventually, a large part of the estate of Edward S. Harkness will go to the Commonwealth Fund.

Many of the largest gifts of the past year for educational purposes have centered about the Chicago area. From the estate of Mrs. Clara A. Abbott $1,500,000 has been left to Northwestern University, and $1,000,000 to the University of Chicago, for the advancement of medical, chemical and surgical science. The University of Chicago has also received $2,000,000 through a bequest of the late Orson C. Wells for medical education and research. From the estate of Mrs. Margaret Gray Morton $2,000,000 has been given for the erection and endowment of a hospital for medical research, to be the fourth unit of the Northwestern University Medical School at Chicago. Wesley Hospital is now constructing on this campus the third unit, made possible by a gift of $1,660,000 from G. Herbert Jones. The Field Museum of Natural History during 1939 received gifts totaling over $700,000. In addition to these benefactions, large gifts of real estate have been made by Albert D. Lasker and Marshall Field, III, to the University of Chicago.

Omaha's art museum, the Joslyn Memorial, has received a further gift of $2,500,000 from Mrs. Sarah H. Joslyn. Among other large gifts reported are: from the estate of Frederick W. Vanderbilt, over $1,500,000 to Vanderbilt University; from the estate of Dr. John M. Vincent, $1,500,000 to Johns Hopkins University; from the estate of R. Wistar Harvey, an estimated $1,000,000 to be divided between the Philadelphia Museum of Art and the Pennsylvania Hospital; and from the estate of Mrs. Cora Ligett Fowler, of St. Louis, $1,000,000 for a hospital.

Announcement has recently been made in Cape Town of provision for a trust fund valued at about $1,000,000 under the will of the late Sir Abe Bailey, leading citizen of South Africa and one of the principal mine owners of the Transvaal. Its purpose is to encourage the teaching of Afrikaans in English schools, to send students, particularly Afrikaans, as visitors to England and other parts of the Empire, and to assist the Salvation Army.

THE STANDARDS COUNCIL OF THE AMERICAN STANDARDS ASSOCIATION

THE Standards Council of the American Standards Association met in New York on April 10. The council which is in charge of all technical work reported progress on many projects of interest to business as a whole.

In line with the recently announced plans to speed up work on standards needed for defense production, it was announced that the following safety standards on toxic substances would be developed under the Emergency Procedure: Acetone, Azides (lead and sodium), Cadmium, Ether, Manganese, Tetryl, TNT and Xylol. These and other safety standards are needed to help industrial concerns protect the large number of employees now being turned into jobs requiring contact with toxic or explosive substances. These projects will be developed as quickly as possible under the new Emergency Defense Procedure of the Association. Committees have already been appointed to do the technical work of drafting these standards.

At the request of the committee in charge of developing standards for toxic dusts and gases, the council approved adding a representative from the U. S. Bureau of Mines to this committee. The bureau is carrying on research work in the field which will be valuable to the committee in its future work.

Acting on advice of the Advisory Committee on Ultimate Consumer Goods which coordinates all work in the consumer field, a representative of the Mail Order Association of America was added to that committee. This association includes in its membership the 4 large mail order houses that do a country-wide business—Sears, Roebuck, Montgomery Ward, Spiegel's, and Chicago Mail Order. It naturally has a very vital interest in standardiaztion work in the field of consumer goods. Its members are already active on a number of technical committees.

Still in the consumer field, the Standards Council approved starting a project to work toward more uniform methods of testing color fastness of textiles and to extend work on color fastness into fields not now covered. This work grows out of a need felt on the part of both consumer and retailer groups for some

adequate method of determining the relative color fastness of materials.

A safety code for dry-cleaning operations is planned. This code will deal with the mechanical hazards in dry-cleaning operations and with the toxicity of fumes. The National Association of Dyers and Cleaners has agreed to take leadership in the technical work.

Two standards of general interest to consumers have been initiated. One of these is to develop standards for household electric ranges covering definitions, methods of test, performance, durability, safety, etc. The other is to develop a similar set of standards for electric water heaters.

A progress report received from the committee on sizes for children's clothing indicates that the first standard in this field—body sizes for boys from kindergarten to junior high school—will soon be completed. This will constitute the first step in development of a more uniform and more accurate method of sizing girls' and boys' clothing.

The committee in charge of work in the mining field reported progress on a number of jobs. A preliminary draft code covering quarry operations, including open pit and strip mining, has been completed and will serve as a basis for the work of the committee developing the standards. Progress was reported also on the revision of a standard on electrical equipment in coal mines, on the revision of a standard on wire ropes for mines, and on revision of a standard for ladders and stairs for mines.

A subcommittee was appointed to study the present methods of protecting workers against health hazards arising from dusts and gases in mines.

THE MEMORIAL HOSPITAL, NEW YORK CITY

MEMORIAL HOSPITAL for the Treatment of Cancer and Allied Diseases will spend approximately $130,000 on education and research concerning the cause and treatment of cancer during this year, according to the report of Dr. Cornelius P. Rhoads, director of the hospital.

New gifts are being sought for this purpose and about $70,000 has recently been obtained toward the hospital's research budget. Contributors include Harry Payne Bingham, of New York; M. M. Rippa, of Miami Beach, Florida; Noel D. Sidford, of New York; Lucius N. Littauer, of New York; the Jane Coffin Childs Fund; the Commonwealth Fund; the Egbert C. Fuller Trust; the Holmes Foundation; the Pierre S. du Pont Fund; the J. J. Lerner Dental Fund; the Charles Lerner Research Fund; the Elise Strang L'Esperance Fund; the Research Corporation; Standard Brands; the Rockefeller Foundation, and the Community Trust. Some of these have made previous gifts for the purpose. A bequest also was received from the estate of Lucy A. Kutz, of New York.

The Rockefeller Foundation recently renewed a grant of $60,000 a year for two years, similar to the amount heretofore given by the General Education Board. This is earmarked for clinical and laboratory education and research, as well as for the training of nurses in cancer work.

The hospital conducts a broadly organized program of clinical and fundamental research into the cause, symptoms and treatment of neoplastic diseases. There are eight laboratory departments covering the natural sciences, each with its special staff of scientific experts and assistants. The research covers the field of pathology, chemistry, bacteriology, biology, physics and biophysics and includes study of radiation treatment with x-ray and radium. Particularly important experiments are being carried on in the field of chemical research, including vitamins, spectroscopy and hormones.

Much of the work of the ten clinical services also yields important cumulative data on results of various forms of treatment.

Important research is done in physics. The Department of Radiation Therapy is equipped with all approved apparatus, much of it original, including x-rays from 50 volts to 1,000,000 volts, full body x-radiation and teleradium therapy for the treatment of tumors by four grams of radium at a distance. The hospital has nine grams of radium in use. There are two low-voltage and five high-voltage x-ray therapy units and one Phillips contact treatment tube.

AWARDS OF THE SOCIAL SCIENCE RESEARCH COUNCIL

EIGHTY awards, amounting to $75,000 for the academic year 1941–42, have been announced by the Social Science Research Council, New York City. The awards provide for study and research in the fields of economics, political science, sociology, statistics, political, social and economic history, cultural anthropology, social psychology, geography and related subjects.

Seven of the awards, carrying a basic stipend of from $1,800 to $2,500, plus travel allowances, cover post-doctoral research training fellowships to men and women under thirty-five years of age who possess the degree of doctor of philosophy or its equivalent. These fellowships are granted for the purpose of enlarging the research training and equipment of promising students through advanced study and field experience.

Thirteen appointments are pre-doctoral field fellowships which carry a basic stipend of $1,800 plus travel allowance. The recipients are graduate students under thirty years of age who have completed

all the requirements for the Ph.D. degree except the thesis. These fellowships are intended to supplement formal academic study by opportunity for direct contact with the materials of social science not available in the classroom or library.

The remaining sixty awards are research grants-in-aid, designed to assist mature scholars in the completion of research projects already well under way. These grants average about $450 and do not ordinarily exceed $1,000. Twelve of these appointments were made through a special fund specifically granted for the purpose of assisting and encouraging the research of social science faculties in the South. The objectives and requirements for eligibility are the same as those governing the national grants-in-aid, but applications are restricted to fourteen southern states.

ENGINEERING AWARDS IN GREAT BRITAIN

THE following awards for 1940 of the Institution of Mining and Metallurgy are reported in *Nature:* Consolidated Gold Fields of South Africa Limited Gold Medal to C. R. Julian for his paper on "Underground Mining at Rio Tinto, Spain"; Consolidated Gold Fields of South Africa Limited Premium of forty guineas conjointly to J. Spalding and T. W. Parker for their paper on "Air-Conditioning Plant at the Ooregum Mine-Kolar Gold Field"; William Frecheville Students' Prize of ten guineas conjointly to J. E. Denyer and K. C. G. Heath for their paper on "Mining and Milling Tin-Tungsten Ore at Mawchi Mine, Burma." The council has also elected H. K. Picard to honorary membership, in recognition of his distinguished services to metallurgy.

The awards of the premiums of the Council of the Institution of Electrical Engineers are: *Institution Premium:* C. F. Booth; *Ayrton Premium:* W. A. Cook; *Fahie Premium:* A. Fairweather and J. Ingham; *John Hopkinson Premium:* G. H. Rawcliffe; *Kelvin Premium:* C. E. R. Bruce and R. H. Golde; *Extra Premiums:* C. G. Garton, L. Gosland and W. F. M. Dunne, Professor Willis Jackson and A. E. Chester, Dr. R. Jessel, W. J. Mason and S. A. G. Emms, G. H. Metson, A. Langley Morris; *Wireless Section Premiums:* N. M. Rust, O. E. Keall, J. F. Ramsay and Dr. K. R. Sturley (Ambrose Fleming Premium), C. A. Mason and J. Moir, Dr. R. H. Barfield; *Meter and Instrument Section Premiums:* Dr. A. E. W. Austen and Dr. S. Whitehead, A. J. King, Dr. R. W. Guelke, C. R. Maguire and Dr. R. A. Scott; *Transmission Section Premiums:* F. R. Perry (Sebastian de Ferranti Premium), Dr. C. Dannatt and R. A. Polson.

DEATHS AND MEMORIALS

DR. JAMES WATERMAN GLOVER, James Olney professor of mathematics, emeritus, at the University of Michigan, died on July 15 at the age of seventy-two years. Dr. Glover had been connected with the university since 1895 when he joined the faculty as instructor of mathematics.

DR. ALADINE CUMMINGS LONGDEN, since 1926 professor emeritus of physics at Knox College, Galesburg, Ill., died on July 12 at the age of eighty-four years. He joined the faculty of Knox College in 1901.

DR. OLAF ANDERSON, professor of petrographic analysis at the Stevens Institute of Technology, died on July 18 at the age of fifty-seven years.

DR. ARTHUR ALBERT WEDEL, specialist in the subsurface stratigraphy of the central Southern States, died on May 7 at the age of forty-three years.

PROFESSOR A. KRYSHTOFOVICH, of Leningrad, has written to inform us of the death in her fifty-second year, on April 12, of Dr. Nina V. Pimenova, paleobotanist and geologist to the Geological Institute of the Ukrainian Academy of Science, Kiev, and lecturer on paleobotany in the State University, and on May 5, in his eighty-fifth year, of Dr. Alexander A. Brauner, director of the Zoological Museum of the Odessa State University, Ukraine, known for his work in the zoology and zoogeography of the U.S.S.R.

DR. PETER VAN DE KAMP, of the Sproul Observatory of Swarthmore College, writes: "A letter received from the Netherlands a few days ago mentions the death of Professor Leonard Salomon Ornstein in Utrecht. Professor Ornstein was born in Nijmegen, Holland, on November 12, 1880. He studied at the University of Leiden, where he was assistant in theoretical physics and received the doctor's degree in 1908. A year later he was appointed lecturer at the University of Groningen; in 1915 he became professor in theoretical physics at the University of Utrecht and was appointed director of the physical laboratory in 1922 as successor to W. H. Julius. His field of study included molecular theory, heat, electricity, optics and liquid crystals. Ornstein's death at the early age of sixty years comes as a shock, since only recently a letter was received in which he reported himself as being in good health."

THE *Journal* of the American Medical Association reports that special ceremonies to dedicate a medallion in Touro Infirmary, New Orleans, were held, June 24, in honor of Dr. Rudolph Matas, who until his retirement in 1935 since 1895 had been affiliated with the institution. A bronze plaque carrying his likeness, executed by Mrs. J. Higginson Manning, New Orleans, was unveiled by Dr. Isidore Cohn, who succeeded him in 1935 as chief surgeon of the infirmary.

SCIENTIFIC NOTES AND NEWS

PRESIDENT ROOSEVELT has designated four members of a medical research committee to specialize on the defense program. The appointees are: Dr. A. R. Dochez, professor of medicine at the College of Physicians and Surgeons, Columbia University; Dr. A. Baird Hastings, Hamilton Kuhn professor of biochemistry at Harvard University; Dr. Alfred N. Richards, professor of pharmacology at the University of Pennsylvania, and Dr. Lewis Hill Weed, professor of anatomy and director of the School of Medicine of the Johns Hopkins University.

THE Trudeau Medal of the National Tuberculosis Association has been awarded to Dr. John Alexander, professor of surgery at the Medical School of the University of Michigan and surgeon in charge of the division of thoracic surgery of the university hospital.

THE Adams Prize of the University of Cambridge has been awarded to Dr. H. Davenport, lecturer in mathematics in the University of Manchester.

DR. J. ENRIQUE ZANETTI, professor of chemistry at Columbia University, has reported for active duty in Washington as colonel in the Chemical Warfare Service.

DR. WILLIAM CHURCH OSBORN, a trustee of the Metropolitan Museum of Art, New York City, since 1904, has been elected president of the museum to succeed George Blumenthal, who died on June 27.

DR. G. WALTER STEWART, professor and head of the department of physics at the State University of Iowa, was advanced on June 20 from the vice-presidency to the presidency of the American Physical Society at its meeting at Providence, R. I. Dr. George B. Pegram, of Columbia University, who had been president since the first of the year, resigned on account of other duties. Dr. P. W. Bridgman, professor of physics at Harvard University, was elected vice-president. Dr. Pegram continues as treasurer of the society.

NEWLY elected officers of the American Society of Plant Physiologists for the year 1941–42 are: *President,* Professor E. C. Miller, of Kansas State College; *Vice-president,* Dr. W. E. Loomis, of Iowa State College; *Secretary-treasurer,* Dr. P. J. Kramer, of Duke University; *Member of the Executive Committee,* Professor W. F. Loehwing, of the State University of Iowa; *Member of the Editorial Board,* Professor O. F. Curtis, of Cornell University.

AT the last meeting of the Sigma Xi Club of the Colorado State College the following officers were elected for the coming year: *President,* Dr. Lloyd E. Washburn, department of animal husbandry; *Vice-president,* Dr. Ruth Sumner, department of physiology; *Secretary-treasurer,* Professor Wesley E. Pyke, High Altitude Laboratory.

DR. BYRON L. ROBINSON, professor of anatomy in the School of Medicine of the University of Arkansas, has been appointed dean of the school. He succeeds Dr. Stuart B. Cromer.

DR. RALPH I. DORFMAN, research assistant with rank of assistant professor in the laboratory of physiological chemistry at Yale University, has been appointed assistant professor of biochemistry in the School of Medicine of Western Reserve University. Dr. Dorfman will be associated also with the Brush Foundation and with the Department of Medicine of Lakeside Hospital.

DR. C. CANBY BALDERSTON has been made dean of the Wharton School of Finance and Commerce of the University of Pennsylvania. Dr. Balderston, who has been professor of industry at the Wharton School since 1931, succeeds Dr. Alfred H. Williams, who resigned on July 1 to become president of the Federal Reserve Bank of Philadelphia.

DR. ALBERT B. NEWMAN, who has been acting dean of the School of Technology of the College of the City of New York, has been appointed dean of the school.

DR. GEORGE C. VAILLANT, associate curator of Mexican archeology at the American Museum of Natural History, New York City, has been appointed director of the university museum of the University of Pennsylvania. He will take office early in September, succeeding Horace H. F. Jayne, who recently resigned to become assistant director of the Metropolitan Museum of Art, New York.

DR. A. J. GROUT, since 1930 a member of the research staff of the Biological Laboratory at Cold Spring Harbor, has been appointed honorary curator of mosses at the New York Botanical Garden. He is now working on mosses for the *North American Flora* with Dr. William C. Steere, of the University of Michigan.

DONALD COLLIER, of the Washington State Teachers College, Pullman, has been appointed curator of South American ethnology and archeology at the Field Museum of Natural History. In September he will undertake an expedition to Ecuador under the joint sponsorship of the Andean Institute and the Field Museum.

DR. FLOYD M. FELDMAN, director of rural health, District Number 3, of the Minnesota State Department of Health, has been appointed health officer of

Rochester. He succeeds Dr. Thomas B. Magath, professor of pathology and parasitology at the University of Minnesota and consulting physician of the Mayo Clinic.

DR. JOHN R. MCGIBONY has been appointed director of health of the U. S. Indian Service. He takes the place of Dr. James G. Townsend, now director of industrial hygiene for the National Institute of Health, who has directed the health division of the service since 1933.

SIR ARTHUR SMITH WOODWARD and Professor Matthew J. Stewart have been elected trustees of the Hunterian Collection of the Royal College of Surgeons, London.

IT is reported in *Nature* that Sir Henry Tizard, rector of the Imperial College of Science and Technology, has been appointed an additional member of the Air Council of Great Britain. In this capacity, and as a member of the Aircraft Supply Council, he will have special responsibility for studying and advising on scientific and technical policy.

ACCORDING to the *News Edition* of the American Chemical Society additions to the staff of the Chemical Engineering Division of the Armour Research Foundation, Chicago, include Dr. Charles A. Coffey, formerly engaged in research for the meat packing industry, who will conduct investigations in oils and fats; Richard Belkengren, Rockefeller Foundation fellow at the University of Minnesota, assigned to further development of a process for rot prevention in shipment and storage of produce; Walter J. Armstrong, who has been engaged in graduate research at the State University of Iowa, to work on engineering process problems; Dr. Raymond G. Spencer and Carl C. Gamertsfelder to conduct x-ray diffraction and spectroscopic research, in the division of light and optics of the University of Minnesota. Dr. Spencer is on leave of absence from Albion College, where he is head of the department of physics.

DR. M. C. WHITAKER, vice-president of the American Cyanamid Company, is again chairman of the advisory committee for the eighteenth Exposition of Chemical Industries. The exposition will be held in the Grand Central Palace, New York, from December 1 to 6. Advance reservations already account for practically all the available exhibit space. Members of the committee include Dr. Raymond F. Bacon, chemical engineer of New York City; Dr. L. H. Baekeland, honorary professor of chemistry at Columbia University; Dr. W. S. Landis, of the American Cyanamid Company, president of the Chemists' Club; Raymond R. Ridgway, president of the Electrochemical Society; John V. N. Dorr, president of the Dorr Company; Walter J. Murphy, editor, *Chemical Industries;* Dr. H. E. Howe, editor, *Industrial and Engineering Chemistry;* Dr. William L. Evans, president of the American Chemical Society; Dr. W. T. Read, dean of chemistry, Rutgers University; Charles F. Roth, manager of the exposition; H. J. Schnell, general manager, *Oil, Paint and Drug Reporter;* E. K. Stevens, associate manager of the exposition; W. D. Merrill, president, Salesmen's Association of American Chemical Industry; R. Gordon Walker, vice-president, Oliver United Filters, Inc., and Dr. E. R. Weidlein, director of the Mellon Institute.

THE National Advisory Cancer Council has recommended the following grants-in-aid: the University of California (Robert S. Stone and E. O. Lawrence), $9,750 in aid of research on the effect of fast neutrons on human cancer; Memorial Hospital, New York City (C. P. Rhoads, George T. Pack), $5,000 in aid of metabolic studies on patients with gastric cancer; the Society of the New York Hospital (George J. Heuer), $5,000 for clinical researches in the early diagnosis of gastric cancer and the comparative value of clinical methods, with special reference to cancer control, and the University of Rochester (John J. Morton), $5,000 for the study of the relation of diet and eating to human gastric cancer, to be carried out as part of a cooperative endeavor in several centers.

COLIN C. SANBORN, curator of mammals for the Field Museum of Natural History, sailed from New York on July 18 on a six months' expedition to southern Peru. The main part of his work will be concerned with research on native bats, in continuation of work begun in 1938 under a fellowship of the John Simon Guggenheim Foundation. The part of Mr. Sanborn's explorations sponsored directly by the Field Museum will be for the purpose of the continuation of the collection of specimens and data begun in 1939–40 when he went to Peru as a member of the Magellanic Expedition. At Arequipa he will be joined by an advanced student from a Peruvian university. Collecting will be carried on in southern Peru in localities ranging from sea level to an altitude of more than 15,000 feet on the plateau above Lake Titicaca. He will work also along the west coast, and in three river valleys in the eastern interior of the country, and returning, in the central and northern sections of Peru.

THE New York City Aquarium in the Battery will be closed on October 4. According to a statement made by Park Commissioner Moses, most of the fish will be moved to an aquarium to be built in the New York Zoological Park, the Bronx. It is questionable, however, whether they will be kept there or removed later to a new aquarium. The New York Zoological

Society, which administers the Aquarium at the Battery and the Bronx Zoological Park, is making a survey to determine the best site for a new aquarium.

THE third summer conference of the New England Association of Chemistry Teachers will be held at the University of Connecticut, Storrs, from August 12 to 15. A symposium is planned on the afternoon of each day on modern concepts of electrolytes. George B. Savage, Loomis School, Windsor, Conn., is chairman of the conference committee.

THE eleventh annual meeting of the American Malacological Union will be held at Thomaston and Rockland, Maine, from August 26 to 29.

THE second American Congress on General Semantics will be held on August 1 and 2 at the University of Denver.

THE summer meeting of the Pennsylvania Academy of Science will be held in Bedford, Pa., over the week-end of August 8–9. Field trips to study the local natural history will be taken. For further information write to Dr. V. Earl Light, Lebanon Valley College, Annville, Pa.

THE Society of American Bacteriologists, the American Association of Immunologists and the American Society for Experimental Pathology would like to receive nominations for the Eli Lilly and Company Research Award in Bacteriology and Immunology. This award is to be made to the young man or woman working in a college or university, who in the opinion of the Award Committee, has done "the most outstanding work in the field of bacteriology or immunology." To be eligible for the award, the individual must not have passed his or her thirty-fifth birthday on April 30, 1941. Information concerning the award may be secured from I. L. Baldwin, University of Wisconsin, Madison. Nominations must be in his hands before September 15.

DISCUSSION

INDUCED BIOTIN DEFICIENCY AS A POSSIBLE EXPLANATION OF OBSERVED SPONTANEOUS RECESSIONS IN MALIGNANCY

MORE than 300 authenticated cases of spontaneous recession of malignant tumors in man have been reported in the literature by a number of authorities between 1890 and 1917. Rohdenburg, who compiled a comprehensive summary of these cases,[1] records that about a hundred of these recessions have been observed to take place "subsequent to, or during, an acute infection." Recessions had been observed to occur after smallpox, pneumonia, malaria and acute tuberculosis. However, "the greater number of cases in this group," Rohdenburg found, "have occurred after an attack of erysipelas, an observation which led to the use of toxins of the causative organisms as a therapeutic measure" (Coley's Fluid).

Recently, West and Woglom, in studies on the biotin content of tumors and other tissues,[2] found it "significant that in every case studied the biotin level of the tumor deviated sharply from the normal adult values in the same direction as that of the corresponding embryo tissues." For example, they found a fourfold increase in the biotin content of the embryo lung as compared with the normal adult lung of the rat, while the biotin content of cancerous tissues from the human lung was found to be about three times the biotin content of the normal tissues of the human adult lung. "Other tumors of epithelial origin, obtained from human sources," they reported, "have also been found directly richer in the growth substance (*i.e.*, biotin) than adjacent normal tissues."

It is by now well established that biotin, found last year to be identical with coenzyme R and vitamin H, the anti-egg-white-injury factor,[3] is essential for the vital functions of many organisms[4, 5, 6, 7, 8] and higher animals.[9, 10] No form of bacteria has so far been found that does not require it, though some have been found to possess the ability to synthesize it from available materials. Eakin, McKinley and Williams have shown that the tissues of chicks on a diet causing egg-white injury were deficient in biotin despite the abundance of this vitamin in the diet.[11] Later, Eakin, Snell and Williams[12] presented experimental evidence to show that commercial or fresh egg white is capable of inactivating biotin *in vitro*, "owing probably to the

[1] G. L. Rohdenburg, *Jour. Cancer Research*, 3: 193, 1918.

[2] P. M. West and W. H. Woglom, SCIENCE, 93: 525, 1941.

[3] P. György, D. B. Melville, D. Burk and V. du Vigneaud, SCIENCE, 91: 243, 1940; V. du Vigneaud *et al.*, SCIENCE, 92: 62, 1940; P. György *et al.*, SCIENCE, 92: 609, 1940.

[4] F. Kögl and B. Tönnis, *Zs. phys. Chem.*, 242: 43, 1936.

[5] P. M. West and P. W. Wilson, *Enzymologia*, 8: 152, 1940.

[6] R. Nilsson *et al.*, *Ann. Landw. Hochschule Schwedens*, 7: 301, 1939.

[7] E. E. Snell and R. J. Williams, *Jour. Am. Chem. Soc.*, 61: 3594, 1939.

[8] J. R. Porter and M. J. Pelczar, *Jour. Bact.*, 41: 173, 1941.

[9] P. György, *Jour. Biol. Chem.*, 131: 733, 1939.

[10] P. György *et al.*, SCIENCE, 91: 243, 1940.

[11] R. E. Eakin, W. A. McKinley and R. J. Williams, SCIENCE, 92: 224, 1940.

[12] R. E. Eakin, E. E. Snell and R. J. Williams, *Jour. Biol. Chem.*, 136: 801, 1940

formation of a fairly stable compound of biotin with a special constituent of egg white." György *et al.*[13] later reported the isolation of a special constituent from raw egg white, called by them "avidalbumin" (recently changed to "avidin"), which showed itself more potent than egg white in producing egg-white injury, and also in biotin-binding capacity *in vitro*, thus establishing avidin as the special egg-white-injury constituent in raw egg white. This led them to assume that egg-white injury is a biotin-deficiency, brought about by "the unavailability of biotin because of its fixation to the avidalbumin" (avidin).

These developments, taken as a whole, lead to certain logical assumptions which, if proved to be correct in future experimental and clinical tests, would provide at least one explanation for the hitherto unexplained phenomenon of the spontaneous recessions in malignancy. For this reason the writer feels justified in offering the following as working hypotheses:

(1) Both the malignant cells and the micro-organisms associated with the observed cases of spontaneous recession require excess biotin for their metabolic activities. Two lines of evidence mentioned earlier would seem to support this hypothesis.

(2) If this hypothesis is proved correct, and it should not be too difficult to check, then the spontaneous recessions could be explained as the direct result of biotin-deficiency brought about by the avidin-like action of the micro-organisms, and particularly the streptococcus erysipelatos, depriving the malignant cells of a factor vital for their continued existence.

(3) The dermatitis in erysipelas may in itself be a human form of egg-white injury, *i.e.*, unavailability of biotin brought about by the avidin-like action of the erysipelococcus.

(4) Raw egg white, or avidin, because of their ability to deprive pathogenic bacteria and malignant cells of a life-essential factor, suggest themselves as new therapeutic agents in conditions due to the presence of these entities. The resultant biotin deficiency could be controlled at any desired stage by the administration of definite amounts of biotin.

Butter-yellow rat liver tumors are relatively low in biotin[2] but this fits well into the general picture, as West and Woglom found the biotin content of the heart, liver and kidney of embryos to be appreciably lower than that of the normal adult heart, liver and kidney. Since the liver is known to act as the storage depot for vitamins of the B complex, the low biotin content of the butter-yellow rat liver tumors may be taken as an indication that tumor tissues of the liver do not possess the function of storage. If that is so, and this assumption seems logical in the absence of any evidence to the contrary, then the relatively low biotin content of the butter-yellow liver tumors, not necessarily low in absolute values, may be explained on the grounds that the tumors have used up the stored biotin, thus giving added support to hypothesis I.

While it is probable that some, if not most, of these suggestions are now under consideration, or are being tested, by others, they are hereby presented in the hope that they may prove useful in crystallizing an idea.

WILLIAM L. LAURENCE

[13] P. György *et al.*, SCIENCE, 93: 477, 1941.

PRE-EUCLIDEAN GREEK MATHEMATICS

IN a recent number of the well-known German periodical entitled *Mathematische Annalen,* dated January 14, 1941, it is announced that the "Jablonowskischen Gesellschaft der Wissenschaften" is offering a prize of R. M. 500 for an investigation which will increase our knowledge of the older Greek arithmetic and algebra, especially of the arithmetic of the Pythagoreans, of which it is stated here very little has been transmitted to us. The hope is expressed in this announcement that the recent discoveries with respect to the mathematics of the ancient Babylonians and the writings of the ancient Greeks relating to music may unitedly be able to throw new light on Greek arithmetic. Competing mss. for this prize are to be written either in German or in Latin and will be received by the said association up to the end of the year 1942.

A significant feature of this announcement is that it emphasizes the wide-spread and growing recognition of the fact that our present knowledge of the ancient Greek mathematics is still very imperfect, notwithstanding the enormous extent of the writings on this subject in recent years. Some years ago it was commonly regarded as sufficient to collect and quote Greek authorities, but in view of the fact that many of these are contradictory and were written long after the supposed discoveries to which they relate were made much less credence is now commonly given to these quotations than formerly. At least they are no longer regarded as final. The much more difficult method of examining critically the authenticity of various statements has been widely adopted, and this has naturally greatly increased the labors of the mathematical historians. This has been true, in particular, as regards many of the discoveries which have been commonly credited to Pythagoras, including the famous theorem known by his name but which was used by the Babylonians many centuries before Pythagoras was born.

The fact that the competing mss. for this prize are to be written either in German or in Latin is somewhat striking, but it can readily be understood when it is

remembered that in 1936 a mathematical periodical was started in Germany under the title *Deutsche Mathematik,* which has since then been widely supported by German mathematical writers even if the contents exhibit the fact that mathematics is an international subject which contains many evidences of the cooperation of writers of many lands. In recent years the German contributions have been extensive, but they were largely based on the earlier contributions of writers in other lands including the Greeks whose achievements the noted prize may help to clarify and to whom the entire mathematical world has often acknowledged itself indebted notwithstanding the growing credit to earlier civilizations.

This prize and the recently reported appointment of a professor of the history of mathematics in the University of Berlin seem to imply that this history is now receiving relatively much attention in Germany, notwithstanding the fact that the present disrupted condition in scientific work makes the unbiased study of this subject very difficult. The articles in the periodical noted in the preceding paragraph also indicate an emphasis on the history in recent German mathematical writings. In so far as these efforts are directed towards learning the actual situations they naturally receive the approval of all and should be especially appreciated in America in view of the relatively small amount of such work in our rapidly expanding mathematical activities of recent years. According to Felix Klein the thinking through of old problems by new methods is the source of pure mathematics.

G. A. MILLER

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CROSS-FERTILIZATION OF ECHINODERMS

IT has long been known that the sea urchins *Strongylocentrotus purpuratus* and *S. franciscanus,* will cross-fertilize, reciprocally, but every investigator has noted that the percentage of cross-fertilizations is extremely variable. During a recent stay at the Hopkins Marine Station at Pacific Grove, Calif., it was found that the variability was largely due to the method of preparing the eggs for experimental use. The usual procedure of preparing sea urchin eggs is as follows:

The ovaries are removed from the cut animal and placed in a fairly large quantity of sea water; this is filtered through cheese-cloth to remove the débris from the exuded eggs; some investigators advocate several washings of the eggs with fresh sea-water; then a small quantity of the eggs are pipetted off into a Syracuse watch glass containing fresh sea water, and the sperm added. Using eggs prepared in this manner, it was found that when crossed with the sperm of the other species, very few eggs were fertilized, though 100 per cent. fertilizations occurred with the sperm of its own species. If, however, the eggs were taken directly from the ovary of the cut animal and left crowded together in sea water in a Syracuse watch glass and immediately fertilized with the sperm of the other species, quantities of the eggs were fertilized. In the cross, *Strongylocentrotus purpuratus* ♀ × *S. franciscanus* ♂, the percentage, in one experiment, was 1 per cent. fertilizations with eggs prepared in the usual way (well washed and separated), and 80 per cent. with eggs direct from the ovary and crowded. The same batch of eggs, and sperm from the same male, were used in the experiment, and the counts were made of the blastulae just before swimming. The experiment was repeated with many different batches of eggs with the same general result; the reciprocal cross gave similar results, but the difference was not so great. In all cases, a large quantity of sperm was used, as it has long been known that over-insemination increases cross-fertilizations.

When the eggs of the sea urchin, *Strongylocentrotus purpuratus,* were crossed with the sperm of an entirely different genus, *Dendraster excentricus,* a sand-dollar, not a single fertilization was observed when the eggs were prepared in the usual way. But when the eggs from the same female were taken directly from the ovary and left crowded together and crossed with the sperm from the same *Dendraster* male, 10 per cent. of the eggs were fertilized.

Loeb has shown that increased alkalinity of the sea water favors cross-fertilizations. In the present case, we should expect an increased acidity due to the accumulation of CO_2 around the unwashed eggs. However, bubbling CO_2 through the sea water did not increase the percentage of cross-fertilizations; possibly the optimum CO_2 tension was not attained. Keeping the eggs for several hours slightly increased the percentage of cross-fertilizations. Sea water in which unfertilized eggs had been kept for 4 to 24 hours (at about 8° C. for the longer periods) gave a slightly higher percentage of cross-fertilizations for fresh eggs than did fresh sea water. It would certainly seem that some substance diffuses from the eggs which favors cross fertilizations and that this is present in effective quantity when the eggs are unwashed and crowded.

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PHOSPHORESCENCE OF HUMAN TEETH

THE fluorescence of teeth is usually intense white with an occasional yellowish or greenish tinge. In older persons the fluorescence shifts into the longer wave-lengths, becoming reddish. Reddish fluorescence is also noted in the teeth of diseased persons.[1] A. H.

[1] J. A. Radley and J. Grant, "Fluorescence Analysis in Ultra-Violet Light." New York: D. van Nostrand Company, Inc., 1939.

van den Bergh and Hyman[2] attribute the red fluorescence of teeth to the presence of a porphyrin, and Tiede and Chromse[3] ascribe red fluorescence in teeth to the presence of proteins, since they were able to duplicate the luminescence of natural teeth by heating apatite preparations with proteins.

Radley and Grant,[1] in their discussion of the fluorescence properties of human teeth do not mention the existence of phosphorescence. To the knowledge of the writer phosphorescence in living human teeth has not been previously noted.

In an apparently healthy twenty-year-old male medium green phosphorescence of several seconds duration was excited in both upper and lower teeth by short wave-length filtered (CG 986) ultraviolet radiation from a cold mercury-quartz lamp. Ultraviolet radiation of longer wave-lengths, *e.g.*, 3600 A.U., failed to excite this phenomenon in the same teeth. Green phosphorescence was also noted in the teeth of older persons.

It would be interesting to study the phosphorescence of teeth in relation to disease, deficiency of diet, poisoning and other conditions, since the action might provide a simple diagnostic measure for certain pathological states.

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SCIENTIFIC BOOKS

RECENT PUBLICATIONS OF THE BRITISH MUSEUM (NATURAL HISTORY)

SINCE the review of British Museum publications in SCIENCE, December 6, 1940, the following have come to hand:

John Smart. Instructions for Collectors, No. 4A. Insects. 1940. 164 pp. A very useful little illustrated manual, giving an account of the various groups of insects and the methods of collecting and preserving them. It is just the sort of book which will be useful to a beginner or amateur and it must be emphasized that those who make no pretense to profound scientific knowledge may nevertheless do very important work as collectors, if they will learn how to do the work and follow advice as to what to collect. It would have been a good thing if the author, in his introductory remarks, had cited some of the results of the work of amateur collectors, as he could so easily have done from his experience at the museum. In the chapter on "Collecting Apparatus and Methods," I am surprised to find no mention of gelatin capsules, so useful when collecting small insects in the field. One's first reaction, on receiving such a book in the midst of a tragic war, is to wonder why it should be issued at this time. Aside from the feeling that normal scientific work should be continued even in wartime as far as circumstances permit, along with other activities which help to keep us sane and hopeful, there are special reasons for promoting entomology under the present circumstances. During the last war important collections and studies were made in various countries, and the work on mosquitoes and lice, in particular, proved important in relation to the health of the armies. At the present time, men are stationed at various localities in Africa and Asia, where the insects are imperfectly known. Much time is spent in guarding rather than fighting, and it is a good thing to cultivate amateur scientific interests to prevent boredom and add to the joy of life. In Britain, also, there are groups of men all over the country, whose duty it is to watch and wait, always ready to meet any emergency that may arise, but most of the time with nothing particular to do. We have been much concerned to furnish reading matter for these groups, but in addition, amateur scientific interests are very helpful, and it is easy and inexpensive to collect insects. Among the smaller insects, many discoveries or original observations may be made even in Britain. There is still another service which entomology may render. Many persons who have been injured leave the hospitals partly cured, and there is a period, sometimes a long period, before they can resume their normal occupations. For such people arrangements have been made for instruction in the manual arts, such as bookbinding, but equally valuable is the development of a scientific hobby, which may be continued through life. Having all these matters in mind, we no longer feel that Dr. Smart's guide is superfluous, even in wartime.

Ruwenzori Expedition. Vol. II, No. 4—Coenosiinae, by F. D. Van Emden; No. 5. Empididae, by C. Garrett Jones. These two papers on African flies are of interest to specialists, but they also serve to emphasize what has been said above concerning collectors. In a series of Empididae collected, it was found that the great majority (39 species) consisted of previously unknown species. Only three, in fact, had previously been described. Most of the material was collected by Dr. F. W. Edwards, the master student of Diptera, whose recent death we so greatly deplore.

Great Barrier Reef Expedition. The Biology of Reef-Building Corals. By C. M. Yonge, July, 1940.

[2] A. H. van den Bergh and Hyman, *Konigkl. Akad. Wetensch. Amsterdam wisk. natk. Afd.*, 36: 1096, 1927.
[3] E. Tiede and H. Chromse, *Ber.*, 67B: 1988, 1934.

A very interesting, beautifully illustrated report, discussing the characteristics of coral reefs, nutrition, adaptations of reef-building corals, significances of the Zooxanthellae, effect of light on coral growth, reproduction and development, growth of corals, maintenance of reefs, form of coral reefs, distribution of reef-building corals and evolution of reef-building corals. To this is added an account of the appearance of living coral polyps, by Professor T. A. Stephenson.

This is the sort of book which should be in every university department of zoology. I have been especially struck by an observation, quoted from Hedley, concerning the effects of excessive rainfall on coral reefs in certain localities. It appears that between January 22 and 29, 1918, a total of 35.7 inches of rain fell at Bowen, Queensland, and this coincided with the full moon spring tides. A thick layer of fresh water floated far out on the surface of the sea. When the low tide fell, this surface water sank till the whole reef was immersed in it. Then every living thing that dwelt there—corals, worms, shell-fish and crabs—died immediately. Putrefaction from these enlarged the zone of destruction. This slaughter reached as deep as 10 feet below mean tide level. Crossland describes a similar devastation of corals at Tahiti during exceptional rainfall in January, 1926.

During the past spring, Santa Barbara and adjacent regions were visited by excessive rains, which from the nature of the slopes must have resulted in a great deal of fresh water pouring into the sea. There are no coral reefs, but we may wonder what may have been the effect on the plankton and on the animals of the littoral zone.

John Murray Expedition. Vol. II. No. 5. Chemical and Physical Investigations, by A. F. Mohamed, of the University of Cairo. The pH observations made in the waters of all oceans and seas until 1934 are reviewed, and the detailed observations made in the northwestern Indian Ocean are recorded, with a discussion of the effects of the hydrogen-ion concentration on the life in the sea.

Vol. VI, No. 8. Ostracoda, by H. Graham Cannon. An account of the comparatively few Ostracoda obtained, one of the species being new.

The Francis Walker types of Trichoptera in The British Museum. By Cornelius Betten (Cornell University) and Martin E. Mosely (British Museum). June, 1940. 248 pp. With a portrait of Walker and many illustrations in the text.

Francis Walker was responsible for sixty-eight little volumes published by the British Museum between 1844 and 1873. It is estimated that some 50,000 species of insects were catalogued as being in the collections of the museum, and very many were described as new. It will be readily understood that this work had to be done in a more or less superficial manner to cover so much ground, and later generations have condemned Walker because they could not make out his species from the brief descriptions. In the preface to the present volume it is stated that Walker's catalogues "are an example of the unwisdom of allowing the curatorial needs of museum work to outweigh its scientific standards." Yet it is only fair to recognize that nearly a hundred years ago taxonomic methods were poorly developed in comparison with those of to-day, and even in quite modern times very many species (especially of Lepidoptera) have been described in a manner which would hardly permit their recognition without specimens or illustrations. As the Walker types are nearly all in the British Museum, they are available for study, and the present volume gives a critical account of Walker's species of caddisflies. The treatment is full and exact; of Walker's 101 specific names, 78 are retained, two are found to be preoccupied, and 21 are synonyms. Most of the species are from North America, and the book will be invaluable to all students of American Trichoptera.

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SOCIETIES AND MEETINGS

THE SEVENTH ANNUAL WASHINGTON CONFERENCE OF THEORETICAL PHYSICS, MAY 22–24, 1941

TOPIC

THE topic of the Seventh Washington Conference of Theoretical Physics, May 22 to 24, 1941, was the theory of elementary particles. The elementary particles known at the present time are: The light-quantum; the electron; the proton; the neutron; the positron; the neutrino; and the meson. The rapid development of this field is illustrated by the fact that the last four of these particles were unknown before the last decade. The main subdivisions of the topics discussed at the conference were (1) elementary particles in cosmic rays, (2) elementary particles in nuclei and (3) field theory.

PARTICIPANTS

Sixteen physicists representing eleven universities were invited to act as conveners of the conference. Besides these, eighteen guest-physicists took part, representing twelve universities, government departments and private research organizations. In order to keep the group small enough to make possible

efficient discussion the effort was made to limit attendance, other than the invited conveners, to those whose work is in intimate relation to the topic of the conference.

SCHEDULE

There were three general meetings on the afternoons of May 22 and 24 at the Administration Building of the Carnegie Institution of Washington and on the afternoon of May 23 at the George Washington University. Dr. Fermi at George Washington University gave a lecture at 8 P.M., May 23, on the elementary particles; those participating in the conference, the members of the Washington Colloquium and the general public were invited. During the mornings of May 23 and 24 there were informal discussions in which smaller groups of the conference took part.

SUMMARY OF DISCUSSIONS

The discussion on the afternoon of May 22 was led by Dr. Oppenheimer. The main topic was the theory of the meson. The meson is a particle discovered in the cosmic rays. The meson has a charge which is equal to the charge of the electron and its mass is intermediate between the masses of the electron and the proton. The meson is not present in the cosmic radiation when it arrives at the earth's atmosphere but is created by some collision between the original cosmic-ray particles and constituents of the atmosphere. The meson is not stable but can disintegrate into some other particles whose nature is not yet established definitely. The existence of the meson and its important rôle in the structure of the atomic nucleus have been suspected even before the discovery of this particle in cosmic rays. The main problems discussed concerning the meson were the magnitude of its spin or angular momentum and the value of its magnetic moment. The evidence from the behavior of mesons in cosmic rays makes it highly probable that the value of the angular momentum is zero or one half in the quantum units of angular moments. The magnetic moment is zero if the angular momentum is zero, and there is reason to believe that the magnetic moment is in accordance with Dirac's theory of spinning particles if the angular momentum is one half. It was suggested that the meson may have the angular momentum but that a change in sign would be connected with the reflections of a meson-wave function in space. This means mathematically that the meson is represented by a pseudo scalar rather than a scalar. This assumption has important bearing on the meson-theory of nuclear forces and on the theory of beta-decay.

A further point in this discussion concerned the number of mesons obtainable in a single collision suffered by a cosmic-ray particle. It has been suspected for some time that mesons are created in large batches or showers. At the conference it was suggested that mesons and nuclear particles interact strongly and that this strong interaction may account for the great number of mesons created simultaneously. The interesting part of this explanation is that in spite of the strong interaction there does not result a particularly strong scattering of the mesons by the nuclear particles.

On the second afternoon Dr. Wigner was the leader of the discussion. The discussion centered around the structure of more complex nuclei. These nuclei can absorb electromagnetic waves just as atoms do, but while atoms absorb ordinary or ultraviolet light the radiation absorbed by nuclei is of much shorter wavelength and is called gamma-radiation. The question of most interest about this gamma-radiation arises from its unexpectedly small interaction with nuclei. The interaction is much smaller than one would expect from the rough picture of an oscillating elementary charge which is confined in its motion to the small dimensions (10^{-12} cm) of a nucleus. The possibility was discussed that this simple "dipole" interaction must be replaced by a "quadrupole" interaction arising from the oscillation of several charges whose main effects cancel each other. A second question discussed at the same time was concerned with the decay possibility of the beta-active substances. Nuclei showing beta-activity emit either an electron or a positron and in addition a neutrino. The neutron is a particle whose existence has been postulated to avoid contradictions with the law of energy conservation and other conservation laws. The decay probabilities in the beta-activity depend on the assumptions about angular momenta and other properties that the two ejected particles possess at the moment when leaving the nucleus. It has been attempted to draw some conclusions about these properties from the empirical facts of the beta-decay

The attempt was also made to find systematic relations between the composition of the nuclei and their beta-decay. The beta-decays in the series He^6, B^{10}, C^{10}, C^{14} proved to be particularly difficult to understand. These nuclei consist of an even number of neutrons and an even number of protons. The number of neutron-pairs differs from the number of proton-pairs by $+1$ or -1. In spite of this similarity in structure the beta-decay periods differ so strongly that it seems necessary to assign the He^6 and C^{10} decays to allowed transitions while assuming that the decays of B^{10} and C^{14} are strongly forbidden.

The discussion of the third afternoon session was led by Dr. Weisskopf. The main problem was the nature of the forces represented by various fields

which have been used both in classical physics and in modern theory. If, as it is assumed at present, nuclear forces are due to emission and absorption of mesons by nuclear particles then it is probable that within the nucleus the classical concept of a field of forces must be abandoned. But it was brought out at the conference that even one of the oldest field theories—the theory of electromagnetic fields—is open to serious revision when investigated in small regions of space, particularly when applied in the immediate neighborhood of elementary particles. One of the most radical suggestions that was put forward would abandon completely the concept of a field and would reintroduce instead the idea of interaction of particles at a distance.

The question of artificial-meson production was discussed and here there seems to be some hope of practical results as soon as it becomes possible to bombard nuclei with protons of about 100 million volts. It was found that even at such high bombardment-energies the influence of binding-energies within the nucleus remains important. Artificial production of mesons would probably help very greatly in understanding the nature of elementary particles and of nuclear forces.

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SPECIAL ARTICLES

ON THE HORMONAL ACTIVITY OF A STEROID COMPOUND

EXPERIMENTS on immature adrenalectomized rats have shown that Δ^5-3-hydroxy-21-acetoxy-pregnene-20-one or acetoxy-pregnenolone (A.O.P.), an intermediary product in the Steiger and Reichstein[1] synthesis of desoxycorticosterone acetate (D.C.A.), possesses pronounced corticoid[2] activity. This finding was deemed worth recording, since up to the present no artificial steroid has been shown to possess corticoid potency and A.O.P.—though simpler to manufacture than D.C.A.—has not been assayed for any possible biological activity.

TABLE I

ACTION OF A.O.P. ON ADRENALECTOMIZED RAT*

Treatment	Hemoglobin in g/100 ml of blood	Glucose in mg/100 ml of blood	NaCl in mg/100 ml of blood	N.P.N. in mg/100 ml of blood	Deaths
Oil	14.1	68	410	142	4
A.O.P.	9.0	108	471	82	0
	P=0.02	P=0.02	P=<0.01	P=<0.01	

* All figures in the table represent averages of each group. The significance of the apparent differences between treated and untreated animals was evaluated by "Student's" method for small samples and is expressed in terms of probability estimated by graphic interpolation in Fisher's table of t.[3] It is generally agreed that differences may be regarded as significant if P is smaller than 0.05.

In our first experiment 5 male and 5 female immature albino rats (weighing 35 to 46 g) were treated once daily subcutaneously with 2 mg of A.O.P. in 0.1 ml of peanut oil on 4 consecutive days, their adrenals having been removed on the first day of treatment. They were killed 6 hours after the last injection simultaneously with 5 male and 5 female adrenalectomized controls (weighing 34 to 47 g) treated with 0.1 ml of peanut oil only. The results summarized in Table I clearly indicate that this treatment was beneficial as judged by its ability to maintain life, to prevent the hemoconcentration (detectable by the rise in blood hemoglobin determined with Evelyn's photoelectric colorimeter), the decrease in blood chlorides (expressed as NaCl determined by Van Slyke's method), the hypoglycemia (Schaffer-Hartmann-Somogyi method), and the rise in blood N.P.N. (Folin and Wu method modified for microdetermination with the Evelyn photoelectric colorimeter).

In order to gain quantitative data concerning the corticoid potency of A.O.P. the compound has been assayed in doses ranging down to 120 gamma per day given in two subcutaneous injections to adrenalectomized rats weighing 38 g on the average. It was found to be only slightly less active than D.C.A. as judged by the ability of this dose of the two compounds to maintain life and permit growth in the absence of the suprarenals. The only apparent qualitative difference between the action of the two steroids appears to be that, unlike D.C.A., A.O.P. caused no adrenal cortical atrophy in intact female rats weighing 100 g and receiving 15 mg of the compound subcutaneously on 20 subsequent days.

Similar experiments revealed that 1^5-3-hydroxy-pregnene-20-one likewise possesses corticoid activity.

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[1] M. Steiger and T. Reichstein, *Helvet. chim. Acta*, 20: 1164, 1937.

[2] The term "corticoid" is used here instead of the cumbersome designation "adrenal cortical hormone-like" in accordance with the recently proposed terminology of the steroid hormone actions (H. Selye, *Nature*, in press).

[3] R. A. Fisher, "Statistical Methods for Research Workers," 6th Edition, Edinburgh, 1936, p. 128.

THE HUMAN EXCRETION OF CAROTENOIDS AND VITAMIN A[1]

WE have examined the intestinal excretion of vitamin A, carotene and xanthophyll in human subjects, in order to provide an objective measure of the dietary content of these substances, and to determine upper limits for their intestinal absorption.

Weighed samples of fresh feces were ground with equal weights of anhydrous sodium sulfate, and the powdery mixture was soxhletted with n-pentane. The extract was saponified under nitrogen in 6 per cent. KOH in methanol. The non-saponifiable fraction was partitioned between benzine and 90–95 per cent. methanol, to separate epiphasic "carotenes" from hypophasic "xanthophylls." Both fractions recombined, or portions of the original extract, were brought into chloroform for the antimony chloride reaction with vitamin A. All concentrations were measured with the Pulfrich Photometer by methods previously described.[2] The average recovery of added carotene or xanthophyll was 80 per cent., of added vitamin A 74 per cent. The qualitative efficiency of the extraction and fractionation procedures was checked spectrophotometrically.

A number of earlier investigations of carotenoid excretion have underestimated the time required for these substances to pass through the intestine.[3] The excretion of single large doses of carotene or xanthophyll in cottonseed oil ordinarily begins within 24 to 48 hours, rises to a maximum in the third to fifth days, and ceases in the fifth to seventh days or even later, depending upon the size of the dose. A single determination of feces carotenoid yields information, therefore, not on the vagaries of a single meal, but on the level of carotenoid ingestion over a considerable period. This factor stabilizes the measurements, and adds greatly to their general usefulness.

EXCRETORY LEVELS

Single samples of feces from 20 subjects eating well-balanced unrestricted diets contained 13.5–328 (av. 122) μgm. of carotenes, and 4.72–47.2 (av. 26.0) μgm. of xanthophylls per gram fresh weight. One subject whose total carotenoid excretion on an unrestricted diet was followed for 30 days yielded very similar results: 11.7–286 (av. 142) μgm. of carotenes and 8.9–105 (av. 29.0) μgm. of xanthophylls per gram of feces. The daily excretion of this subject averaged 74.5 grams; in 3 other subjects it averaged 53, 103 and 165 grams. The average water content varied between 71 and 75 per cent. The carotenoid concentration is relatively independent of the day-to-day bulk of the feces, even when this is increased by adding agar to the diet. It is curious that the carotene content of these "normal" feces is about equal to that of green leaves. The relative proportions of carotenes and xanthophylls, however, are the reverse of those in the leaf, apparently due to the preferential absorption of xanthophylls in the human intestine.

On passing from a high-carotenoid diet to one designed to contain the equivalent of about 100 I.U. of vitamin A daily, the feces carotenoid concentrations in 11 subjects dropped to 0.69–5.47 (av. 2.99) μgm. of carotenes and 0.79–3.73 (av. 2.00) μgm. of xanthophylls per gram. In two subjects whose diets were controlled more rigidly for long periods, the level of excretion fell still lower, to 1.22–1.70 μgm. of carotenes and 0.94–1.18 μgm. of xanthophylls per gram. The feces carotenoids provide, therefore, a sensitive index of the carotenoid levels of the diet.

Even at the lowest intake levels the feces carotenoids are virtually entirely of dietary origin. On passing from a high to a low-carotenoid diet, the rate of excretion falls to the new level within 5 to 7 days. When carmine is fed with the last high-carotenoid meal, the concentration of excreted carotenoid continues to fall no more than a day longer than carmine continues to appear in the feces. Furthermore, at the lowest excretory levels the daily excretion is still only about 70–80 per cent. of the daily intake, measured by direct extraction of 24-hour replicas of the diet. Only negligible amounts of feces carotenoids, therefore, can originate in intestinal organisms or by excretion from internal reserves through the intestinal wall.

PROPORTIONS EXCRETED

The excretion of carotene in cottonseed oil (the leaf mixture containing about 90 per cent. β- and 10 per cent. α-carotene) was determined in two subjects. Five experiments were performed, with ingestion periods ranging from a single dose to 10 days of regular feeding, and daily intake varying between 1.88 and 19.6 mgm. The fractions excreted in these experiments were 61.3, 60.8, 57.3, 69.7, and 49.3; average 59.7 per cent.

In similar experiments in which crystalline leaf xanthophyll in cottonseed oil was fed at the rate of 10.1 mgm. daily, the average excretory rate in one subject was 10.5 μgm. per gram feces, and the total

[1] This research was supported in part by a grant to G. W. from the Josiah Macy, Jr. Foundation. Halibut liver oil and general dietary supplements were generously supplied by the Abbott Laboratories of North Chicago, and carotene by the S. M. A. Corporation of Chicago.

[2] G. Young and G. Wald, *Amer. Jour. Physiol.*, 131: 210, 1940.

[3] *Cf.* H. E. C. Wilson, S. M. Das Gupta and B. Ahmad, *Ind. Jour. Med. Res.*, 24: 807, 1937.

excretion during an ingestion period of 16 days was 8.3 per cent. of the intake.

When vitamin A in halibut liver oil was fed at a level of 23.7 mgm. per day (about 76,000 I.U.), the excretory rate in 6 subjects averaged 20.6 μgm. (about 66 I.U.) per gram feces. The total excretion in two subjects during ingestion periods of 8 and 16 days was 3.97 and 2.74 per cent. of the intake. At still higher intake levels the excreted fraction rose sharply. Conversely, when the daily intake was reduced to about 25,000 I.U., the excretory rate in one subject fell to about 1/10 of its previous value, and a second subject excreted no measurable amount of vitamin A at all. In no case could we obtain a test for vitamin A from the feces of subjects on unrestricted, unsupplemented diets. It appears from these experiments that, unlike carotene or xanthophyll, vitamin A is not excreted until the intake reaches a threshold value, well above all ordinary dietary levels; and that above this the fraction excreted rises with the intake.

De has performed experiments similar to these in the rat.[4] He found the excretion of vitamin A in halibut liver oil to be 3 to 5 per cent. over a wide range of intake levels. The average excretion of carotene in oil was 42.5 per cent., or only about two thirds of that in our experiments on human subjects.

In bioassay experiments on rats, vitamin A is almost exactly twice as potent as an equal weight of β-carotene.[5] If one assumes that the fractions of vitamin A and carotene not excreted are absorbed—the excretion in any case sets an upper limit to the absorption—such apparent absorptions explain adequately the relative potencies of these substances in the rat.[4] By a parallel argument, due to its low apparent absorption, carotene in human bioassay should be at best only about 40 per cent. as effective as an equal weight of vitamin A; and should possess only about two thirds the potency now assigned to it on the basis of rat assays. Some confirmation of this conclusion has already appeared in human bioassay experiments.[6]

It is not now known whether β-carotene is converted to vitamin A *in vivo* by symmetrical cleavage, according to the equation

$$C_{40}H_{56} + 2\,H_2O \longrightarrow 2\,C_{20}H_{30}O \qquad (1);$$

or by stepwise degradation to yield a single molecule of vitamin A. In the former instance carotene and vitamin A should be about equally potent *in vivo;* in the latter, carotene should be only about half as potent as the vitamin. The fact that in rats the different potencies of these substances are explained by their differential absorptions implies that *following absorption* they are about equally effective, and is strong presumptive evidence for the operation of equation (1). The present experiments indicate a similar possibility in man.

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CORRELATION OF ACTIVITY PER UNIT WEIGHT OF TOBACCO-MOSAIC VIRUS WITH AGE OF LESION

IT has been assumed by investigators working with plant viruses that each virus particle attains its full biological activity as soon as it is formed and that any increase in activity is due to an increase in the number of these infectious units. This would infer that all virus samples prepared under identical conditions should have the same activity per unit weight of virus regardless of the source of the sample. Examination of the literature reveals little experimental evidence in support of this assumption. What evidence there is has been derived from activity measurements of crude plant juice. Such measurements have given no information regarding the possible presence of infectious particles of different sizes and weights.

The development of the ultracentrifuge for virus isolation and purification, together with improvements in the local lesion method for measuring the activity of tobacco-mosaic virus, has made it possible to study virus samples containing known weights of virus protein. This technique has been applied to a study of the virus content and relative activity of preparations extracted at various intervals after inoculation. It was soon found[1] that under nitrogen-deficient conditions there was a falling off in activity per unit weight of virus. This finding led to a critical examination of the biological activity of virus in newly formed lesions.

Turkish tobacco plants (*Nicotiana tabacum* L.) were grown in nutrient sand cultures and supplied a complete nutrient solution. When about 6 inches tall, the plants were inoculated by rubbing over the entire upper surface of one mature leaf on each plant with a suspension of tobacco-mosaic virus (*Marmor tabaci* H.). At 5-day intervals, inoculated leaves from representative plants were harvested, frozen and then minced. The cold juice was cleared of insoluble materials by low-speed centrifugation and then ultracentrifuged. The sediment was suspended in phosphate buffer, cleared by low-speed centrifugation and again ultracentrifuged for 1 hour. Virus-protein content was calculated from the nitrogen content of the suspension of the sediment from the second ultra-

[4] N. K. De, *Ind. Jour. Med. Res.*, 24: 751, 1937.
[5] T. H. Mead, S. W. Underhill and K. H. Coward, *Biochem. Jour.*, 33: 589, 1939.
[6] L. E. Booher, E. C. Callison and E. M. Hewston, *Jour. Nutrition*, 17: 317, 1939.

[1] E. L. Spencer, *Plant Physiol.*, 16: 229, 1941.

centrifugation. The biological activity per unit weight of virus protein in this suspension was assayed on bean plants (*Phaseolus vulgaris* L. var. Early Golden Cluster) by the local lesion method, as modified by Spencer and Price.[2] The results were as follows: The content of virus protein in the inoculated leaf continued to increase for as long as 20 days after inoculation. This was a point of immediate interest, as it had been generally supposed that the virus reached its maximum concentration in the inoculated leaf within 7 to 10 days following inoculation. From the activity measurements, it was further found that the activity of the virus protein 5 days after inoculation was only about 25 per cent. of that of virus protein isolated 15 days later. Between the 5th and 10th days, the activity of this material almost doubled, and the increase continued until a maximum was reached about 20 days after inoculation. Therefore, not only the amount of virus protein but also the activity per unit weight of the material increased up to 20 days. This would indicate that virus in young lesions was lower in activity than that from somewhat older lesions. Subsequently, it was found that virus protein from the inoculated leaf was more active than that isolated at the same time from the top of the plant. This result might have been expected in view of the previous experiment, since it can be assumed that part of the virus lesions in the inoculated leaf were formed earlier than any of those in the top of the plant and therefore were somewhat older.

In regard to the characteristics of virus from young and old lesions, preliminary analyses with the ultracentrifuge have shown that a preparation from the old lesions had only one component. However, a sample of virus from young lesions prepared at the same time appeared to be made up of two components, one of which was about double the length of that of the other as determined by the sedimentation constant.

Experiments also indicate that nitrogen may be an important factor in increasing the activity per unit weight of virus *in vivo*. When nitrogen was withheld 10 days after inoculation, virus protein in the inoculated leaf continued to form at about the normal rate for a limited period, but the activity of this material, on a weight basis, remained fairly constant at the level reached about the time when nitrogen was last added. The activity at this point was about one half that ultimately displayed by virus protein from normal nitrogen-fed plants. Preliminary experiments have indicated that it may even be possible to increase this unit activity *in vitro* by supplying the virus with suitable forms of nitrogen.

The observations clearly show that virus in young lesions displays on a unit weight basis only a fraction of its potential biological activity and that such virus may vary somewhat in size and shape from virus isolated from older lesions.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

MEASUREMENT OF RESPIRATION AND GLYCOLYSIS OF A SINGLE SAMPLE OF TISSUE IN SERUM

WITH the development of a sensitive method of colorimetric analysis for lactic acid[1] and the "neutralized" serum technique for the manometric measurement of oxygen consumption of tissues suspended in serum,[2] it has become possible to determine in an ordinary Warburg vessel the rates of respiration and glycolysis[3] of a single sample of tissue suspended in serum. Respiration is determined manometrically and glycolysis chemically. At the beginning of the experimental period, a sample of approximately 0.2 cc of serum is tipped from the main vessel onto a few crystals of sodium fluoride in the side-well. The fluoride prevents glycolysis in the few cells which may enter with the serum. The tissue slices are prevented from being tipped in by first inclining the vessel in the opposite direction, allowing the slices to settle and decanting the serum. At the end of the experimental period, a 0.1 cc sample of this serum is analyzed for the initial lactic acid concentration. The serum remaining in the side-well is returned and mixed with the contents of the main vessel and a 0.1 cc sample of this serum is analyzed for the final lactic acid concentration. The amount of lactic acid produced by the tissue during the experimental period is given by the formula

$$X_{Lac} = (C - C_o)\ (V_o - V_1), \text{ where}$$

X_{Lac} = mg. of lactic acid formed during experimental period.
C = Lactic acid concentration in mg./cc. at end of experimental period.
C_o = Lactic acid concentration in mg./cc. at beginning of experimental period.
V_o = Volume of serum originally placed in vessel (usually 2 cc.).
V_1 = Volume of serum removed from side-well (usually 0.1 cc.).

[2] E. L. Spencer and W. C. Price, *Amer. Jour. Bot.*, 28: (in press), 1941.

[1] S. B. Barker and Wm. H. Summerson, *Jour. Biol. Chem.*, 138: 535, 1941.

[2] J. MacLeod and C. P. Rhoads, *Proc. Soc. Exper. Biol.*, 41: 268, 1939. A. Canzanelli and D. Rapport, *Amer. Jour. Physiol.*, 127: 296, 1939. C. O. Warren, *Amer. Jour. Physiol.*, 128: 455, 1940. D. G. Friend and A. B. Hastings, *Proc. Soc. Exper. Biol.*, 45: 137, 1940.

[3] Used in the restricted sense of meaning lactic acid formation.

During the experimental period, the oxygen consumption is determined manometrically in the usual way, with KOH in the center well to absorb CO_2. One advantage of this method over differential manometry for measuring tissue respiration in serum is that the time-course of respiration may be followed, and by using vessels equipped with more than one side-well, additional samples of serum may be withdrawn at intervals to follow the time-course of glycolysis.

Tests of the method show that the same figure for $Q_G^{O_2}$ is obtained by this "side-well technique," where only the serum is analyzed, as by the usual method of analyzing separate samples at the beginning and end of the experiment and including the tissue in the analysis. In the case of bone marrow, the only tissue so far studied by these methods, the Q_{O_2} is the same in neutralized as in unaltered serum,[4] but the $Q_G^{O_2}$ is higher in neutralized serum, apparently an effect of the absence of CO_2. This finding may not apply to other tissues.

These methods may of course be used with any medium, but they are particularly useful when it is important to use serum, to conserve tissue and to use as few manometers as possible. The chemical method of measuring glycolysis has the advantage of being virtually specific for lactic acid, and accuracy is gained by making the initial and final analyses on one sample of tissue rather than on separate samples, as in the usual way.

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THE PRESERVATION OF OXIDIZABLE SUBSTANCES IN SOLUTION[1]

CERTAIN chemical and biological preparations, notably those used for growth stimulation or containing natural sulphydryl complexes are prone to gradual oxidation and subsequent loss of potency when in solution. Shinohara[2] has given formulas for these inactivating oxidations and our own work Owen[3] on tissue extracts are in fair agreement with his findings.

After attempting to prevent oxidation in these solutions by refrigeration, tightly capping the vials and employing antioxidants with a minimum of success we found the following procedure to be effective. The embryonic extract or solutions are prepared in the usual manner either aseptically or with permissable amounts of preservative. These are then strained or filtered as desired. The preparation is then placed in open beakers or wide-mouthed screw cap vials and set at room temperature into a vacuum desiccator. The pump is started and sufficient vacuum applied to cause mild bubbling of the solution but little or no loss in volume by evaporation. Usually not over five minutes pumping is required to remove the dissolved air. The vacuum is then replaced with an inert gas, as carbon dioxide, slowly let in. The containers are filled to the top and the cap screwed on and tightened before removal from the desiccator. Low melting paraffin may also be used to seal the containers. All air must be excluded to insure protection from oxidation.

As an example 1:100,000 cysteine hydrochloride solutions and tissue extracts containing free sulphydryl were maintained at room temperature for over six months with no apparent loss of sulphydryl. Similar solutions not so treated usually gave a negative sulphydryl test after one to four weeks. The method of testing was that used by Owen[3] employing the phospho-18-tungstic acid reagent of Folin and Marenzi.[4]

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[4] C. O. Warren, *loc. cit.*

[5] This work was done during the tenure of a Lewis Cass Ledyard, Jr., Fellowship, New York Hospital, 1940–1941.

[1] Published with the permission of the Medical Director of the Veterans' Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the writers.

[2] K. Shinohara, *Jour. Biol. Chem.*, 109: 665–679, 1935.

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